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MICROALGAE *SCENEDESMUS* SP POTENTIAL IN PHYTOREMEDIATION OF KALIDAMI RETENTION POND WITH POTASSIUM AND CARBON ADDITION

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ABSTRACT

Scenedesmus sp **is a microalga that can be used to treat bodies of water with high levels of nutrients and organic matters. The objectives of this study are (1) to examine the effect of Potassium (K) and Carbon (C) addition on phosphate concentration. The study was conducted on a laboratory scale using a batch system and continuous aeration. Microalgae were cultured until chlorophyll-a concentration of about 3.5 mg/L was obtained. The phycoremediation process was carried out by adding the elements of K and C. The results of this study show that the reactor with the addition of 3% of K and 29.41 mg/L of C generated the lowest phosphate concentration of 1.40±0.01 mg/L.**

KEY WORDS : Domestic waste, *Scenedesmus* sp, Total phosphate

INTRODUCTION

The functions of Kalidami retention ponds is as a controller of water runoff for preventing marine pollution and aquaculture. Urban waste usually contains high levels of nitrogen, phosphate (PO_4^{3-}), and organic matter. Domestic waste in Surabaya City contains orthophosphate between 0.44 mg/L and 1.08 mg/L, 15,000 mg/L of COD, and 9,000 mg/L of BOD (Wijaya and Soedjono, 2018). A high level of (PO_4^{3-}) in a water body can cause eutrophication (Piranti *et al*., 2018), reducing the dissolved oxygen (DO) in the water.

Microalgae such as *Chorella vulgaris* (Oktavitri *et al.*, 2019), *Chlamydomonas*, *Spirulina*, *Scenedesmus*, *Nostoc*, *Oscillatoria*, and *Synechoccytits* (Purnamawati *et al*., 2015) can be used to treat wastewater (Bwapwa *et al*., 2017). *Scenedesmus sp* is a freshwater green microalga that has a role in the bioremediation of high productivity eutrophic waters (Tripathi and Sumaty, 2017). *Scenedesmus sp* is a microalga, which can grow in all types of freshwater, plays an important role as a primary producer, and contributes to the recovery of eutrophic water. *Scenedesmus sp* is widely used for waste treatment because it reduces nutrients by a high percentage *(Acevedo et al., 2017)*, (Kabir *et al*., 2017); (Romaidi *et al.*, 2018). However, environmental condition such as pH, light intensity, organic and incorganic substance for *Scenedesmus sp* is important to produce high growth rate (Mohamed *et al*., 2019). Thus far, there has been no research on the effect of adding potassium (K) and Carbon (C) on phosphate (PO_4-P) concentration. This research aims to examine the effect of K and C nutrient addition to PO_4-P concentration.

MATERIALS AND METHODS

The initial step of this research was culturing algae from ponds in Bulusidokare Village, Sidoarjo, East Java. The characterized algae usually used for treated wastewater by chlorophyll-a algae concentration at around 3.5 mg/L (Nurhayati *et al*., 2019). The algal culture was carried out using a plastic tube reactor with a volume of 25 L and aerating it using RC 410 type aerators, exposing it to sunlight, and adding it with NPK fertilizer (Ratnawati *et al*., 2017).

Table 1. Research Reactor Codes

Reactor Code	Element K (KH_2PO_4 + K_2HPO_4) (%)	Element C (Sucrose) (mg/L)
Control	0	0
0K	0	0
1K	1	0
3K	3	0
0KC	0	29.41
1KC	1	29.41
3KC	3	29.41

Before the phytoremediation process began, a preliminary analysis of retention pond water was carried to determine the characteristics of the water before treatment, especially for the parameters of COD, BOD, PO_4-P, DO, and pH. COD was analyzed using the APHA 5220 C method, BOD using SNI 06-6989 72-2009, PO_4-P using the APHA 4500 PE method, Ed 22, 2012, DO using SNI 06-6989,14-2004 method, and pH using SNI 06-6989.11-2004.

The phytoremediation process of retention pond water was conducted in *batches* using an 8 L glass tube reactor in a greenhouse and aerated continuously using RC 410. The test reactor used retention pond water added with algae culture with a ratio of 1:3. The research variables are the addition of element K in the form of KH_2PO_4 + K_2HPO_4 with the concentration of 0%, 1% and 3% of the total K, Bold's Basal Medium (BBM), and the addition of element C in the form of sucrose with the concentration of 0 mg/L and 29.4 mg/L. This study is also complemented with a control reactor that only contains retention pond water. Each reactor was coded as shown in Table 1. Analysis of PO_4-P, was performed on days 0, 3, 6, 9, 11, 13, 16, and 18.

RESULTS AND DISCUSSION

Characteristics of Kalidami Retention Water

The level of DO in retention pond water that cannot be detected shows that the DO level was very low. Some microalgae can photosynthesize, so they can increase DO levels and decompose pollutants in the waters (Panggabean and Prastowo, 2017). The BOD and COD levels of the retention pond water were beyond the specified quality standards. The BOD/COD ratio was 0.45, indicating that the water of the Kalidami retention pond is easily decomposed by microorganisms (Tamyiz, 2015). Therefore, the right treatment is a biological treatment, one of which is phytoremediation.

Table 2 showed the level of PO_4^{3-} in the retention pond water was 1.18±0.04 mg/L. The level of PO_4-P in the retention pond water exceeds the quality standards, which can cause eutrophication (Oktavia *et al.,* 2014). PO_4-P concentration during the study can be seen in Figure 1, which points out that the addition of element K (KH_2PO_{4+} K_2HPO_4) and element C (sucrose) affected PO_4-P level. On day 0, the PO_4-P level in the test reactor was higher than that in the control reactor and the level varied between 2.7 mg/L and 4.47 mg/L, whereas in the control reactor, the PO_4-P^- level was 1.29 mg/L. The differences in PO_4-P level on day 0 were caused by the addition of varying elements of elements K and C. Aside from being a source of element K, the addition of KH_2PO_4 and K_2HPO_4 also became a source of PO_4-P.

During the study, the PO_4-P level in all test reactors from day 3 to day 6 decreased dramatically, especially in reactors into which element K was added (1K and 3K) without the addition of element C and in reactors into which elements K and C were added (1KC and 3KC). Phosphorus available in wastewater will be bound by microalgae for cell formation, growth, and maturation of cells, as well as forming new protoplasms (Oktavia *et al*., 2014). The reactions that occur in algal photosynthesis in the presence of phosphorus (Equation 1) (Setoaji and Hermana, 2013):

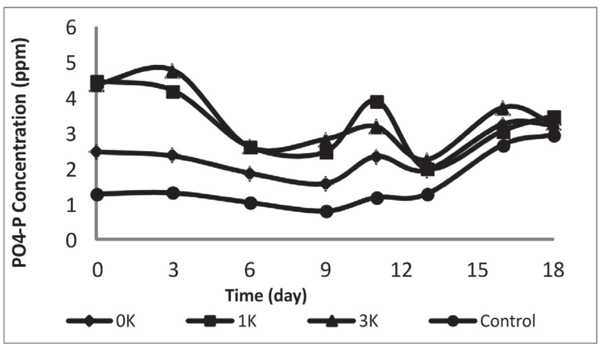
$$106CO_2 + 236H_2O + 16NH_4^+ + HPO_4^{2-} \rightarrow C_{106}H_{181}O_{45}N_{16}P + 118O_2 + 171H_2O + 14\,H^+ \quad ..\,(1)$$

The results showed that the largest decline in phosphate level occurred in the 3KC reactor, which is the reactor added by 3% of K and sucrose, on day 6. The 72% decline resulted in 1.40 ± 0.01 mg/L of PO_4-P. The process of phosphate decline also occurred because there was algae-bacteria symbiosis in the retention pond water (Pasaribu *et al.,* 2018). Using *Scenesdesmus sp* as water treatment is more effective rather than biofiltration. Purwanti (2018) explained that organic matter removal in

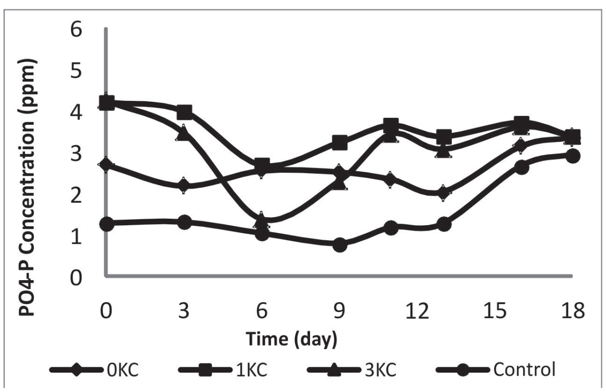
Table 2. Initial Characteristics of Kalidami Retention Pond in Surabaya

Parameter	Unit	Quality Standart *)	Test Results
Total phosphate as P (PO_4-P)	mg/L	1.0	1.18±0.04
DO	mg/L	≥ 3	Not detected
COD	mg/L	50	132.48±0.04
BOD_5	mg/L	≥ 3	60.85±0.92
pH	-	6 - 9	7.24±0.00

biofiltration is below 15%, but different result explained by Ningrum (2018). Sand filtration equipped with aeration could remove the organic matter above 65% (Ningrum, 2018).



(a) Addition of element K



(b) Addition of elements K and C

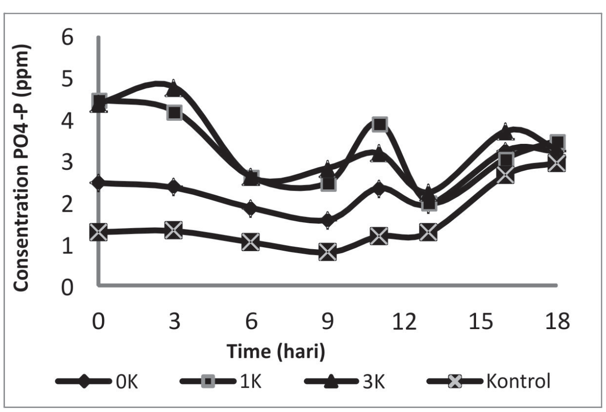


Fig. 1. Phosphate concentration troughout the research after the addition of elements K and C

The higher the growth of algae, the more inorganic compounds are absorbed by the algae, resulting in reduced levels of phosphate (Nurhayati *et al.*, 2019). The microalgae underwent an exponential phase, the phase when the growth of microalgae occurs very quickly (Ramírez *et al.*, 2018). *Scenesdesmus sp* is an alga that is easily adapted, so it was able to grow well at the beginning of the study. The increase and density of cells were affected by the addition of elements C, P, and N (Subagiyo *et al.*, 2016). The results of this study are higher than some previous studies, (Oktavia *et al.*, 2014), (Soeprobowati *et al.*, 2013).

The algae were in a stationary period from day 9 due to the depletion of nutrients and energy reserves in the media, so the growth of microalgae tended to be static. In this phase, the growth of microalgae coincided with the death of microalgae (Selvika *et al.*, 2016), (Mardalena, 2016).

CONCLUSION

From this study, it can be concluded that the addition of elements K and C affected the concentration of PO_4-P. The lowest concentration of PO_4-P occurred in the reactor that was added by 3% of element K and 29.4 mg/L of C (3KC) on day 6, which was 1.40±0.01 mg/L with a removal efficiency of 72%.

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